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Anti-Fuzzy Lateral Ideals in Regular Γ-Ternary Semigroups

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ABSTRACT

Several researchers have concentrated on the triplet operation in algebraic structures in recent years. The primary purpose of this article is to represent a characterisation of fuzzy ideal and anti-fuzzy ideal in regular Γ-ternary semigroups by using some preliminary concepts and basic results of Γ-ternary semigroups.

Keywords: Γ-ternary semigroups; fuzzy Ideals; Anti Fuzzy ideals; Regular

AMS Mathematics Subject Classification (2010): 20M12, 20M17, 08A72

Abstract in Bengali

সাম্প্রতিক বছরগুলিতে বেশ কয়েকজন গবেষক বীজগণিতীয় কাঠামোতে ত্রিগুণ ক্রিয়াকলাপের উপর মনোনিবেশ করেছেন। এই প্রবন্ধের প্রাথমিক উদ্দেশ্য হল Γ-ত্রিশূন্য অর্ধগোষ্ঠীর কিছু প্রাথমিক ধারণা এবং মৌলিক ফলাফল ব্যবহার করে নিয়মিত Γ-ত্রিশূন্য অর্ধগোষ্ঠীতে অস্পষ্ট আদর্শ এবং অস্পষ্ট আদর্শের বৈশিষ্ট্য উপস্থাপন করা।

1. Introduction

After the establishment of fuzzy subsets by Zadeh, multiple researchers explored the abstraction of the idea of fuzzy sets. Choudhury, Khare and Chakraborty reviewed a fuzzy subgroups and fuzzy Homomorphisms. The analysis of fuzzy semigroups has been started by Kurki. A logical demonstration of fuzzy semigroups communicated by Mordeson et al in 1990. The creation of Γ in algebras was launched by Nobusawa in the past year 1964 as a abstraction of the rings and review in more detail of Γ− rings. Rao commenced the concept of Γ− semirings as an abstraction of Γ− rings in the past year 1995. Biswas presented the hypothesis of anti fuzzy sub-groups of groups. Hong and Joun revised Biswas principles and implemented it to BCK – algebras. Dar and Akram described anti fuzzy left-hand side h-ideals of hemi-rings. The origin of anti-fuzzy ideals of semi-groups was launched by Nawaz, Jeong, and Shabir, and they determined anti-fuzzy prime ideals in a BCK–algebraic system.

This article encloses the results relevant to anti fuzzy left hand side, middle lateral side , right hand side ideals, antie fuzzy quasi ideals and antie fuzzy bi-ideals in regular Γ - ternary semi-groups.

2. Basic preliminaries

Definition 2.1. A nonempty set T be stated as a ternary semigroup when there is one ternary operator $*: T\times\Gamma\times T\times\Gamma\times T \to T$ describe by $(x_1,\alpha,x_2,\beta,x_3) \to x_1\circ\alpha\circ x_2\circ\beta\circ x_3$ holds the below condition

$(x_1\circ\alpha\circ x_2\circ\beta\circ x_3)\circ\gamma\circ x_4\circ\delta\circ x_5 =$

$x_1*\alpha*(x_2*\beta*x_3*\gamma*x_4)*\delta*x_5 = x_1*\alpha*x_2*\beta*(x_3*\gamma*x_4*\delta*x_5)$ for any $x_1,x_2,x_3,x_4,x_5\in T$ $\alpha,\beta,\gamma,\delta\in\Gamma$.

Definition 2.2. A Γ - ternary semigroups T is stated as regular if for every $a\in T$, there exist $p,q\in T$ such that $a = a\alpha p\beta a\gamma q\delta a$ for any $\alpha,\beta,\gamma,\delta\in\Gamma$.

Definition 2.3. An fuzzy sub-set ω in a Γ- ternary semigroups T is stated as an anti-fuzzy left –hand side (right-hand side or middle lateral side) ideals in T if $\omega(p\alpha q\beta r)\le\omega(r)$ ($\omega(p\alpha q\beta r)\le\omega(p)$ or $\omega(p\alpha q\beta r)\le\omega(q)$) for all $p,q,r\in T$ and $\alpha,\beta\in\Gamma$.

Definition 2.4. An fuzzy-subset ω in a Γ- ternary semigroups T is stated as an antifuzzy ideal in T while it is anti-fuzzy left side, right side and middle lateral side ideas of T.

Example: Consider T as a collection of non-positive integers unless zero and Γ is the collection of non-positive even integers unless zero. Then T is clearly a Γ - ternary semigroup where $x\alpha y\beta z$ represents the usual multiplication of integers x, y, z, α, β with $x, y, z, \in T$ and $\alpha,\beta\in\Gamma$. Suppose ω is a fuzzy subset to T, and ω is yield as follows: $\omega(a)=\begin{cases}0.5 & if \quad a=-1\\ 0.3 & if \quad a=-2\\ 0.1 & if \quad a<-2\end{cases}$

Then ω is an anti fuzzy ideal of T.

Definition 2.5. A fuzzy sub semi-groups ω of a Γ - ternary semi-group T is called as an anti fuzzy bi-ideals of T while

$$\omega(m\alpha n\beta p\gamma q\delta r)\le\{\omega(m)\vee\omega(p)\vee\omega(r)\} \text{ for all } m,n,p,q,r\in T$$

and $\alpha,\beta,\gamma,\delta\in\Gamma$.

Example: For all $a,b \in [0,\ 1]$, let $T = [0,\ a]$ and $\Gamma = [0,\ b]$, trivially T is a Γ - ternary semi-groups under ordinary multiplication. Further the fuzzy set f

$T \to [0,\ 1]$ given by $\omega(x) = \begin{cases} 0.1 & if\ \ x \notin Q \\ 0.5 & if\ x \in Q \end{cases}$ is a antifuzzy bi – ideals of T.

Definition 2.6. A fuzzy sub-set ω in a Γ - ternary semi-groups T stated as an antifuzzy quasi ideal of T while it holds the following
$\omega(a) \le \max\{(\omega \circ \chi \circ \chi)(a), (\chi \circ \omega \circ \chi)(a),\ (\chi \circ \chi \circ \omega)(a)\}$
and $\omega(a) \le \max\{(\omega \circ \chi \circ \chi)(a), (\chi \circ \chi \circ \omega \circ \chi \circ \chi)(a),\ (\chi \circ \chi \circ \omega)(a)\}$.

Definition 2.7. If ω_1 , ω_2 and ω_3 is fuzzy sub-sets for a Γ - ternary semi-groups *T*. Then an anti fuzzy multiplication $\omega_1 \circ \omega_2 \circ \omega_3$ is defined by

$$(\omega_1 \circ \omega_2 \circ \omega_3)(x) = \begin{cases} \underset{x=a\alpha b\beta c}{\wedge} \{\omega_1(a) \vee \omega_2(b) \vee \omega_3(c)\} \\ 0 \qquad Otherwise \end{cases}$$

Definition 2.8. If ω is a fuzzy sub-sets in a Γ - ternary semi-groups. Then we defined a set $L[\omega, t] = \{a \in T : \omega(a) \le t\}$ stated as a anti levels cut set of f.

Definition 2.9. A fuzzy sub-set ω to a Γ - ternary semi-groups T stated as idempotent while $\omega \circ \omega \circ \omega = \omega$.

Result 2.10. Consider T as a Γ - ternary semi-groups and $\phi = B \subseteq T$, then B is a bi-ideal to T as long as the characteristic mapping χ_B of B is an fuzzy bi-ideal to T.

Result 2.11. Consider T as a Γ - ternary semi-group and $A, B \subseteq T$ are any Γ - ternary sub semi-groups. Then

(i) $A \subseteq B$ if and only if $C_A \subseteq C_B$

(ii) $C_A \circ T \circ C_B \circ T \circ C_B = C_{A\Gamma T\Gamma B\Gamma T\,B}$

(iii) $C_A \circ C_B \circ C_C = C_{A\Gamma B\Gamma C}$

3. Result and discussion

The results presented in this section expose several important aspects of semigroup theory. The characterization of regular semigroups through anti fuzzy ideals demonstrates the power of these one to one correspondence relations in understanding the internal structure of semigroups.

Theorem 3.1. A fuzzy subset ω of a Γ - ternary semi-group T is an anti fuzzy lateral side ideal of T if and only if f $L[\omega, t] \ne \phi$ is an anti fuzzy lateral side ideal of T.

Proof: Suppose that ω is a an anti fuzzy lateral side ideals of a Γ- ternary semi-groups T.

Let $a \in L[\omega,t]$. Then $\omega(a) \le t$.

But ω is anti fuzzy lateral side ideal of T, we get for any $t \in [0,1]$, $p,q \in T$ and $\alpha,\beta \in \Gamma$, $\omega(p\alpha\, a\,\beta qy) \le \omega(a)$

$\Rightarrow \omega(p\alpha\, a\beta\, q) \le \omega(a) \le t$

$\Rightarrow \omega(p\alpha\, a\beta\, q) \le t$

$\Rightarrow p\alpha\, a\,\beta\, q \in L[\omega : t]$

Therefore $L[\omega,t]$ is an anti fuzzy lateral side ideal of T.

Conversely, assume that $L[\omega,t] \ne \phi$ is an anti fuzzy lateral side ideal of T for all $t \in [0,1]$.

Because $L[\omega,t] \ne \phi$, implies there is a member $a \in L[\omega,t]$ such as $\omega(p\alpha\, a\,\beta\, q) > \omega(a)$ $p,q \in T$, and $\alpha,\beta \in \Gamma$.

For chaise $t \in [0,1]$ such as $\omega(p\alpha a\beta q) > t \ge \omega(a)$, then $a \in L[\omega,t]$.

But $p\alpha a\beta q \notin L[\omega : t]$, which is a contradiction.

Thus $\omega(p\alpha a\beta\, q) \le \omega(a)$.

Therefore ω is an anti fuzzy side lateral side ideals of T.

Theorem 3.2. A non- empty sub set A of a Γ- ternary semi-groups T is a lateral side ideal of T as long as the fuzzy subset ω of T defining as $\omega(a) = \{ \begin{smallmatrix} t, & if \;\; a \in T-A \\ r, & if \;\; a \in A \end{smallmatrix}$ is an anti fuzzy lateral side ideals of T, where $t,r \in [0,1]$ such as $t \ge r$.

Proof: Suppose A is a lateral side ideal of T and let $a,p,q \in T$.

If a in A then $p\alpha a\beta\, q \in A$ implies that $\omega(p\alpha\, a\beta\, q) = \omega(a) = r$

If a is not in A then $\omega(a) = t \ge \omega(p\alpha a\beta q) \Rightarrow \omega(p\alpha a\beta q) \le \omega(a)$

Hence ω is an anti fuzzy lateral sideideal of T.

Conversely suppose that ω is an anti fuzzy lateral side ideals of T.

If $a \in A$ and $p,q \in T$. Then $\omega(p\alpha a\beta\, q) \le \omega(a) = r \Rightarrow \omega(p\alpha a\beta\, q) \le r$

Thus $(p\alpha a\beta\, q) \in A \Rightarrow T\Gamma A\Gamma T \subseteq A$.

Hence A is a lateral side ideal of T.

Theorem 3.3. A fuzzy non-empti sub sets ω of a Γ- ternary semi-groups T is an anti fuzzy lateral side ideals of T if and only if $\lambda \circ \omega \circ \lambda \subseteq f$, where λ is fuzzy subset of T such as $\lambda(a) = 0$, for all $a \in T$.

Proof: Suppose ω is an anti fuzzy lateral side ideal of a Γ- ternary semi-groups T and $p \in T$ such as $p = u\alpha a\beta v$. Then

$$(\lambda\circ\omega\circ\lambda)(p)=\underset{p=u\alpha a\beta v}{\wedge}\{\lambda(u)\vee\omega(a)\vee\lambda(v)\}$$
$$=\underset{p=u\alpha a\beta v}{\wedge}\{0\vee\omega(a)\vee 0\}$$
$$=\underset{p=u\alpha a\beta v}{\wedge}\{\omega(a)\}$$
$$\geq\underset{p=u\alpha a\beta v}{\wedge}\{\omega(u\alpha a\beta v)\}$$
$$=\omega(p)$$
$$(\lambda\circ\omega\circ\lambda)(p)\geq\omega(p)$$
$$\lambda\circ\omega\circ\lambda\supseteq\omega$$

Suppose $p\neq u\alpha a\beta v$ then we have $(\lambda\circ\omega\circ\lambda)(p)=1\geq\omega(p)$

Thus $\lambda\circ\omega\circ\lambda\supseteq\omega$

In other hand suppose that $\lambda\circ\omega\circ\lambda\supseteq\omega$

Choose $u,a,v\in T$. We have $\omega(u\alpha a\beta v)\leq(\lambda\circ\omega\circ\lambda)(u\alpha a\beta v)$

$$=\underset{u\alpha a\beta v=p\gamma b\delta q}{\wedge}\{\lambda(p)\vee\omega(b)\vee\lambda(q)\}$$
$$=\{\lambda(u)\vee\omega(a)\vee\lambda(v)\}$$
$$=\{0\vee\omega(a)\vee 0\}$$
$$=\omega(a)$$
$$\omega(x\alpha a\beta y)\leq\omega(a)$$

Therefore ω is a antifuzzy middle lateral side ideal of T.

Theorem 3.4. An fuzzy sub-sets ω to a regular Γ- ternary semi-groups T is a antifuzzy left hand side and right hand side ideal of T as long as it is an anti fuzzy middle lateral side ideal of T.

Proof: Assume that T is a regular Γ- ternary semi-groups and let ω be an anti fuzzy left hand side and right hand side ideals of T. Then $\omega(p\alpha q\beta r)\leq\omega(p)$ and $\omega(p\alpha q\beta r)\leq f(r)$ for all $x,z,y\in T$ and $\alpha,\beta\in\Gamma$.

To show that ω is anti fuzzy middle lateral side ideals of T.

Consider $\omega(p\alpha a\beta r)=\omega(p\alpha(a\alpha u\beta a\gamma v\delta a)\beta q)$

$$=\omega(p\alpha a\alpha(u\beta a\gamma vq\delta a\beta q))$$
$$\leq\omega(u\beta a\gamma v\delta a\beta q)$$
$$=\omega(u\beta a\gamma v\delta(a\alpha a\beta a\alpha a\beta a)\beta q)$$
$$=\omega((u\beta a\gamma v)\delta(a\alpha a\beta a)\alpha(a\beta a\beta q))$$
$$=\omega(a\beta a\beta y)$$
$$\leq\omega(a)$$
$$\omega(p\alpha a\beta q)\leq\omega(a)$$

Thus ω is an antifuzzy middle lateral side ideals of T.

In other words suppose that ω is a anti fuzzy middle lateral side ideals of T. Then $\omega(p\alpha\, a\beta q) \le \omega(a)$ for all $a, p, q \in T$ and $\alpha, \beta \in \Gamma$.

Suppose $a, b, c \in T$. But T is a regular.

Consider $\omega(p\alpha a\beta q) = \omega((p\alpha u\alpha p\beta\, v\gamma\, p)\delta a\beta\, q)$

$$= \omega(p\alpha(u\alpha\, p\beta v)\gamma\, p\delta a\beta q)$$
$$\le \omega(u\alpha p\beta v)$$
$$\le \omega(p)$$
$$\omega(p\alpha a\beta\, q) \le \omega(p)$$

Therefore ω is an anti fuzzy left ideal of T.

Again $\omega(p\alpha a\beta q) = \omega(p\alpha a\,\alpha(q\beta\, u\gamma q\delta v\beta q))$

$$= \omega((p\alpha a\alpha\, q)\beta(u\gamma q\delta\, v)\beta\, q)$$
$$\le \omega(u\alpha\, q\beta v)$$
$$\le \omega(q)$$
$$\omega(p\alpha a\beta\, q) \le \omega(q).$$

Therefore ω is an anti - fuzzy left ideal of T.

Theorem 3.5. All anti-fuzzy two sided ideals to a regular Γ - ternary semi-groups T are the idempotents.

Proof: Let us assume that T is a regular Γ - ternary semigroup and let us that ω is a anti-fuzzy left side and right side ideals to T. Then $\omega(p\alpha\, q\beta\, r) \le \omega(r)$ and $\omega(p\alpha\, q\beta\, r) \le \omega(p)$ for all $p, q, r \in T$ and $\alpha, \beta \in \Gamma$

To claim that ω is a idempotent. i.e., $\omega \circ \omega \circ \omega = \omega$.

Consider $(\omega \circ \omega \circ \omega)(a) = \underset{a=a\alpha p\beta a\gamma q\,\delta a}{\wedge} \{\omega(a) \vee \omega(p\beta a\gamma q) \vee \omega(a)\}$

$$\ge \underset{a=a\alpha p\beta a\gamma q\,\delta a}{\wedge} \{\omega(a) \vee \omega(a\alpha a\alpha p\beta a\gamma q) \vee \omega(a)\}$$
$$\ge \underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge} \{\omega(a) \vee \omega(a\alpha a\,\alpha p\beta a\gamma q\,\delta a\delta a) \vee \omega(a)\}$$
$$= \underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge} \{\omega(a) \vee \omega(a\alpha(a\alpha p\beta a\gamma q\delta a)\delta a) \vee \omega(a)\}$$
$$= \underset{a=a\alpha x\beta a\gamma y\delta a}{\wedge} \{\omega(a) \vee \omega(a\alpha a\delta a) \vee \omega(a)\}$$
$$\ge \underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge} \{\omega(a) \vee \omega((a\alpha a\delta a)\alpha a\beta a) \vee \omega(a)\}$$
$$= \underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge} \{\omega(a) \vee \omega(a\alpha a\,\delta a\alpha a\delta a) \vee \omega(a)\}$$
$$= \underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge} \{\omega(a) \vee \omega(a) \vee \omega(a)\}$$
$$= \omega(a)$$
$$(\omega \circ \omega \circ \omega)(a) \ge \omega(a)$$
$$\Rightarrow \omega \circ \omega \circ \omega \supseteq \omega \qquad (1)$$

Again $(\omega\circ\omega\circ\omega)(a)=\underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge}\{\omega(a)\vee\omega(p\beta a\gamma q)\vee\omega(a)\}$

$$=\underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge}\{\omega(a)\vee\omega(p\beta a\alpha a\beta a\gamma q)\vee\omega(a)\}$$

$$=\underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge}\{\omega(a)\vee\omega((p\beta a\alpha a)\beta a\gamma q)\vee\omega(a)\}$$

$$\leq\underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge}\{\omega(a)\vee\omega((p\beta a\gamma q)\vee\omega(a)\}$$

$$\leq\underset{a=a\alpha p\beta a\gamma q\delta a}{\wedge}\{\omega(a)\vee\omega((a)\vee\omega(a)\}$$

$$=\omega(a)$$

$$(\omega\circ\omega\circ\omega)(a)\leq\omega(a)$$

$$\Rightarrow\omega\circ\omega\circ\omega\subseteq\omega \qquad (2)$$

From (1) and (2), $\Rightarrow\omega\circ\omega\circ\omega=\omega$

Hence ω is an idempotent.

Theorem 3.6. All anti-fuzzy middle lateral side ideals to a regualar Γ - ternary semi-groups T are idempotents.

Proof: Consider T as a regular Γ - ternary semi-groups and let us assume ω as a antifuzzy middle lateral side ideals to T. Then $\omega(p\alpha q\beta r)\leq\omega(q)$ for all $p,q,r\in T$ and $\alpha,\beta\in\Gamma$.

To claime that ω is a idempotent. That is $\omega\circ\omega\circ\omega=\omega$

Since each anti-fuzzy middle lateral side ideal to T is both anti fuzzy left side and right side ideal of T. Then $\omega\circ\omega\circ\omega\supseteq\omega$ (1)

Now consider $(\omega\circ\omega\circ\omega)(a)=\underset{a=a\alpha p\beta a\gamma y\delta a}{\wedge}\{\omega(a)\vee\omega(p\beta a\gamma q)\vee\omega(a)\}$

$$\leq\underset{a=a\alpha p\beta a\gamma y\delta a}{\wedge}\{\omega(a)\vee\omega(a)\vee\omega(a)\}$$

$$=\underset{a=a\alpha p\beta a\gamma y\delta a}{\wedge}\{\omega(a)\}=\omega(a)$$

$$(\omega\circ\omega\circ\omega)(a)\leq\omega(a)$$

$$\Rightarrow\omega\circ\omega\circ\omega\subseteq\omega \qquad (2)$$

From (1) and (2), we get

$\omega\circ\omega\circ\omega=\omega$

Hence ω is an idempotent.

Theorem 3.7. If ω_1 and ω_2 are arbitray two antifuzzy middle lateral side ideals to a Γ - ternary semigroups T. Then $\omega_1\cup\omega_2$ will be also a antifuzzy middle lateral side ideal in T.

Proof: Let ω_1 and ω_2 be any two anti fuzzy lateral side ideals of a Γ - ternary semigroup T. Then $\omega_1(p\alpha a\beta q)\leq\omega_1(a)$ and $\omega_2(p\alpha a\beta q)\leq\omega_2(a)$ for all $a,p,q\in T$ and $\alpha,\beta\in\Gamma$.

Consider $(\omega_1 \cup \omega_2)(p\alpha a\beta q) = \omega_1(p\alpha a\beta q) \vee \omega_2(p\alpha a\beta q)$

$$\leq \omega_1(a) \vee \omega_2(a)$$

$$= (\omega_1 \cup \omega_2)(a)$$

$$(\omega_1 \cup \omega_2)(p\alpha a\beta q) \leq (\omega_1 \cup \omega_2)(a)$$

Hence $\omega_1 \cup \omega_2$ is a antifuzzy lateral side ideals to T.

4. Conclusions

We have investigated the thought of Antifuzzy ideals to a regular Γ - ternary semigroup and analyzed their properties. We characterize the Anti-fuzzy ideals in Γ (Gamam)-ternary semigroup with respect to regular property and observed their applications in multiple criteria decision making as well as the essential fuzziness in human judgment and preference. In continuous of this paper we propose to study the solution of multi-criteria decision-making problem based on anti fuzzy ideals over Ternary algebras.

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